STUDIES ON TRANSPORTATION OF FISH

I Packaging of Frozen Fish in Insulated Containers

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The paper deals with certain technological aspects of transportation of fish. Frozen fish packed in thermocole insulated plywood box (tea chests) and transported has been found to remain in good condition for 3 to 4 days. Fish reaching the destination in a thawed state can be stored in crushed ice for a further period of 2–3 days. The effect of initial temperature of frozen fish on the storage life, the maximum storage period for different types of frozen fish packed in the insulated container and the changes in chemical and organoleptic qualities of different varieties of fish under condition of transport are also discussed.

INTRODUCTION

The pattern of internal distribution of fish in India has remained more or less unchanged till now in spite of the rapid progress made in the fields of fishing and fish processing. Refrigerated rail wagons have recently been introduced in selected routes for the transport of fish to important cities. However, the quantity of fish transported by this means is negligibly small compared to the vast surplus available for distribution, especially during heavy fishing seasons.

A planned fish distribution system to the internal makets in our country would involve an elaborate net work of ice plants, cold storages and refrigerated vehicles. Areas thousands of kilometres away from the fish landing centres will have to be covered. This means that the fish will have to be maintained in fresh condition for at least 4 – 6 days. Icing alone is not often found to be adequate for this purpose. In tropical temperature conditions ice melts at rapid rates necessitating reicing at frequent intervals to keep the fish at low temperatures. Moreover, rapid meltage of ice affects the quality of fish adversely. The maximum period of ice storage of fish in the round form under the above conditions is also limited. Certain varieties of fish like sardines pose special problems like belly-bursting.

Attempts have already been made to reduce the rate of melting of ice and to increase the storage life of iced fish by providing additional linings to the conventional bamboo baskets used for transport of fish (Rao and Perigreen 1964). Using gunny and polythene lined bamboo basket or kraft paper lined bamboo basket iced fish (1:1) can be preserved for a period of 16-18 hours. The thermocole insulated plywood box developed at the Veraval unit of the institute keeps iced fish (1.1) in acceptable condition for upto 2½ days and this container is now being used for transporting fish to distant places from the Gujarat coast. (Unpublished work by R. Venkataraman; Anon. 1965). A drip proof insulated basket for transport of iced fish has also recently been recommended. (Anon. 1966). Since reicing enroute during transport is not generally practicable due to various reasons and the maximum period for which iced fish can be stored in insulated container is limited to 2½ days and since prolonged storage of fish in ice adversely affects their quality, investigations were initiated with a view to evolving a suitable method for the long distance transport of fish which could avoid the above defects. As an alternative to transport of iced fish, the possibility of quick freezing the fishes and packing in insulated containers before transport were examined in detail with respect to many of the commercially important varieties of fish.

Materials and methods

The fishes used for the study included oil sardines (Sardinella longiceps), jew fish (Sciaena Spp), kalava (Serranus Spp), seer (Scomberomorous Guttatus), tuna (Thymus Thunnina) and caranx (Caranx Melampygus). They were obtained from fishing vessels operating from Cochin. The fishes were washed well and frozen at a temperature of —30°C. to —35°C. Smaller varieties like oil sardines, jew fish etc. were frozen either individually or as unglazed or glazed blocks (20—25% glaze water). Bigger fishes like seer, tuna and kalava were cut into small pieces (average weight 1.5 to 2 kg) depending on the size of the container used for packing the fish and then frozen. The frozen fish were packed with or without ice in plywood boxes of different sizes, viz. 30 cm. × 30 cm. × 30 cm. and 40 cm × 40 cm × 40 cm insulated with 2.5 cm thick thermocole (*loc. cit.*) and stored at room temp. (26 — 32°C). The changes in temperature of the fish at different positions in the container were measured using copper constantan thermocouples previously introduced at these points over a pyrometer. The quality of the fish was judged by chemical and organoleptic tests.

The material packed thus was removed after thawing when the maximum temp attained was 3—4°C and stored in crushed ice with a view to working out the extent to which the fish could be stored further in ice.

The effect of initial temperature of the frozen material on the storage life was studied using frozen glazed blocks of different initial temperatures ranging from —6°C to —34°C. The frozen material packed in thermocole insulated container was also stored at refrigerated temperatures (4 to 7°C) and storage life studied.

The volatile acid number was determined by the method of (A. O. A. C. 1960) and peroxide value and free fatty acids by the methods of Lea (1952) and A. O. C. S. (1946) respectively. The organoleptic evaluations of the fish were carried out after cooking the fish in 2% sodium chloride solution for 10 minutes.

Results and discussion

Table I gives the temperature distribu-

tion in frozen glazed fish blocks at initial temperature of —17.8°C packed in 2.5 cm thermocole insulated plywood box (30 cm^3) and stored at two different temps. viz. room temp. (26—32°C) and refrigerated temp. (4.4 to 7.2°C). It can be seen from the table that the material stored at room temp. attained the maximum temperature—bottom 2.8°C, centre 1.1°C, top 7.2°C after 96 hrs. storage and that stored at refrigerated temperature attained the temp. bottom 1.1°C, centre —0.5°C, top 1.7°C after 192 hours' storage. At the end of the storage period, the fish at the central layer in the container had the lowest temperature followed by the bottom layer and the maximum temperature rise was noticed at the top layers. By lowering the storage temp. to 4.4—7.2°C, the shelf life is increased by twice that at room temperature. The fish at the end of the storage period was in a thawed state.

The maximum storage lives of different types of frozen fish packed in 2.5 cm thermocle insulated plywood box and stored at room temperature with their initial and final temperatures are given in Table II. The individually frozen fish like oil sardines had the minimum storage life i e. 55 hrs. followed by individually frozen seer and tuna pieces packed in the container without ice. The size of individual sardine is very small (wt. 15—35 gms) compared to frozen pieces of seer and tuna (1.5 to 2 kg.). When individually frozen fishes are packed in the insulated container, air gaps are left in between the fishes and in case these gaps an filled up with crushed ice, the storage life can be further increased as shown by the figures in the table. Unglazed frozen blocks packed in the container showed comparatively lower storage life than the glazed frozen blocks. The maximum storage life of 96 hrs was observed in water glazed frozen blocks of fish under the conditions of the experiment. This was followed by individually frozen big fishes like seer, tuna and kalava packed with ice. These two methods of freezing and packing were found to be suitable for sending fish to distant places where the journey lasts for about 3 days.

The storage life of frozen fish packed in the thermocole insulated container is also found to depend on the initial temperature of the frozen material packed (Table III). The lower the initial temperature of frozen fish the longer the storage life. But lowering the initial temp. of the material below —17°C does not have a proportionate effect in extending the storage period.

The changes in volatile acid number, peroxide value, free fatty acids and organoleptic quality of different types of frozen fishes packed in thermocole insulated plywood box and stored at room temp. and on subsequent storage in ice after thawing in the insulated container are given in Table IV. In the case of oil sardines (Av. Wt 15—17 gms, fat content 11—13% on D. W. B.) the fish after thawing in insulated container was in fair condition and showed belly-bursting of 20-25% and during further storage in ice for 2 days the quality became fair to poor and belly bursting increased to 50—60%. The rate of belly-bursting was found to be dependent on the size of the fish and fat content (Table V). The small size sardines which usually contained small amount of fat showed maximum belly-bursting and the big size sardines which contained large amount of fat showed less belly-bursting. Sardine being a fatty fish, the fat undergoes undesirable changes during storage affecting the quality. This is evident from the increase in peroxide value and free fatty acids during storage. Jew fish and kalava which contained only small amounts of fat were in fair to good condition after thawing

TABLE I. TEMPERATURE DISTRIBUTION IN FROZEN GLAZED FISH BLOCKS PACKED IN 2.5 cm THERMOCOLE INSULATED PLYWOOD BOX (30 cm × 30 cm × 30 cm) AND STORED AT ROOM TEMP. (26—32°C) AND REFRIGERATED TEMPERATURE (4.4—7.2C.)

Storage period in hrs.	Storage at room temperature (26 to 32C)			Storage at refrigerated temperature (4.4 to 7.2C)		
	Temperature of fish blocks C			Temperature of fish blocks C		
	Bottom	Centre	Top	Bottom	Centre	Top
0	—17.8	—17.8	—17.8	—17.8	—17.8	—17.8
24	— 3.3	— 3.3	— 2.8	— 8.3	— 9.4	— 6.6
48	— 2.2	— 2.7	— 1.1	— 5.5	— 6.6	— 4.4
72	— 0	— 0.6	1.7	—	—	—
96	— 2.8	1.1	7.2	— 2.8	— 2.8	— 1.7
168	—	—	—	0	— 1.1	0
192	—	—	—	1.1	— 0.5	1.7

TABLE II INITIAL TEMPERATURE, MAXIMUM TEMP. ATTAINED AND MAXIMUM STORAGE PERIOD OF DIFFERENT TYPES OF FROZEN MATERIAL PACKED IN 2.5 cm THERMOCOLE INSULATED PLYWOOD BOX AND STORED AT ROOM TEMP. SIZE OF CONTAINER 30 cm × 30 cm × 30 cm. AMBIENT TEMP 26–32C.

	Material packed	Initial temperature C.	Final Maximum temp. attained C.			Storage period hours.
			Bottom	*Centre*	*Top.*	
(1)	Individually frozen sardines	—17.8	1.6	0	7.2	55
(2)	Unglazed frozen sardine blocks	—17.8	3.0	0.3	8.6	73
(3)	Glazed (water) frozen sardine blocks	—17.8	3.0	1.1	7.2	96
(4)	Individually frozen seer fish	—15	5.5	3.8	7.2	67
(5)	do–with ice	—15	3.8	2.8	6.1	88
(6)	Individually frozen Tuna	—16.6	1.6	0.5	10.0	68
(7)	do–with ice	—16.6	5.5	2.7	7.2	90

TABLE III EFFECT OF INITIAL TEMPERATURE OF FROZEN FISH PACKED IN 2.5cm THERMOCOLE INSULATED PLYWOOD BOX (30 cm^3) AND STORED AT ROOM TEMTERATURE (26–32C).

Material packed : glazed frozen sardine blocks
Maximum temp. attained : 3–4C.

Initial temperature of material C.	Storage period hours
—34	102
—26	100
—17	96
—12	87
— 6	76

TABLE IV CHEMICAL AND ORGANOLEPTIC CHARACTERISTICS OF DIFFERENT TYPES OF FROZEN FISHES PACKED IN THERMOCOLE INSULATED PLYWOOD BOX.

	Material packed	Volatile acid number			Peroxide value ml of n/500 sod. thiosulphate per gm fat)			Free fatty acids (as oleic acid%)			Organoleptic quality		
		I	II	III	I	II	III	I	II	III	I	II	III
1.	Frozen glazed sardine blocks	6.88	11.48	9.18	0.55	13.2	25.34	1.53	3.02	5.69	Good	Overall quality-fair; texture slightly soft	Overall quality-to poor, fair slightly rancid, slightly soft texture
2.	Frozen glazed jew fish blocks	4.06	5.81	7.57	nil	8.11	13.70	2.06	1.92	4.74	Good	Overall quality-fair to good; texture firm	Overall quality-fair; texture firm
3.	Individually frozen caranx	4.32	5.90	7.56	nil	5.50	8.75	2.85	3.52	3.50	Good	Overall quality-fair to good; Texture slightly soft	Overall quality-fair; texture slightly soft
4.	Individually frozen kalava	6.12	7.08	11.66	1.80	8.72	14.06	1.81	2.57	4.13	Good	Overall quality-fair to good; texture slightly fibrous and tough	Overall quality-fair; texture slightly fibrous and tough
5.	Individually frozen seer fish	5.36	6.34	9.75	3.03	4.41	7.76	1.05	1.77	1.68	Good	Overall quality-fair to good; texture slightly	Overall quatity-fair; texture fibrous

I Initial when packed II After thawing in insulated container (Maximum temperature attained 3 to 4 C) III After storing the thawed material in crushed ice for 2 days.

TABLE V RELATION BETWEEN SIZE, FAT CONTENT AND BELLY-BURSTING OF FROZEN OIL SARDINES PACKED IN THERMOCOLE INSULATED PLYWOOD BOX (30 cm³) AND STORED AT ROOM TEMPERATURE (26-32C)

Average weight of sardines gms	Fat content % on D. W. B.	% Belly brusting	
		Before freezing	After thrawing in insulated container
15-17	11-13	nil	20-25
20-23	21-22	nil	8-10
30-35	40-44	nil	0- 3

in the insulated container, and fair condition after further storage for 2 days in ice. In the case of caranx the flesh became slightly soft at the end of the storage period.

SUMMARY

Frozen fish can be kept in good condition upto 4 days in thermocole insulated containers under our atmostpheric temperatures and the fish after thawing in the insulated container when further stored in ice remained in acceptable condition for 2-3 days in the case of many of the commercially important fishes. Trial consignments of fish sent from Cochin to Calcutta by ordinary rail wagon adopting the method reached the destination in good condition. This technique of preservation and transportation has been found to have the added advantage that during peak seasons the excess of fish catch can be frozen and kept in the frozen storage for sufficiently long periods and transported to distant centres as and when required. It will thus facilitate a balanced supply of fish in the internal markets irrespective of the fishing season.

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